Attorney Docket No.: 9405-4 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: Hunter et al.
Serial No.: 10/528,897
Filed: September 24, 2003
For: MODULAR BATTERY MANAGEMENT APPARATUS WITH CELL SENSING AND ENERGY REDISTRIBUTION CAPABILITIES

Group Art Unit: 2838
Examiner: Arun C. Williams
Confirmation No.: 1727

December 1, 2008

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Commissioner for Patents
P.O. Box 1450
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**APPELLANTS' BRIEF ON APPEAL UNDER 37 C.F.R. § 41.37**

Sir:

This Appeal Brief is filed pursuant to the "Notice of Appeal to the Board of Patent Appeals and Interferences" electronically transmitted on September 30, 2008.

## Real Party In Interest

The real party in interest is assignee Eaton Power Quality Co. Ltd., Christchurch, New Zealand.

## Related Appeals and Interferences

Appellants are not aware of any appeals or interferences that would be affected by the present appeal.

## Status of Claims

1-27 remain pending as of the filing date of this Brief. Appellants appeal the final rejections of Claims 1-27 in the final Office Action mailed July 1, 2008 (hereinafter "Final Action"). The attached Appendix A presents the claims at issue.

## Status of Amendments

An amendment filed March 26, 2008 has been entered. No further amendments have been filed.

**Summary of the Claimed Subject Matter**

Some embodiments of the present invention according to independent Claim 1 provide a battery management system for managing a string of cells. The system includes a sensing module (see, *e.g.*, Fig. 12, sensing circuit 1203), a DC/DC converter (see, *e.g.*, Fig. 12, DC/DC converter 1202), a control module (see, *e.g.*, Fig. 12, controller 1206) coupled to the sensing module and the DC/DC converter, and a common line (see, *e.g.*, Fig. 12, DC bus 1208) coupled to both the sensing module and the DC/DC converter and adapted for connection to a battery when in use. The sensing module is configured to receive battery information from the common line and output a sensing signal to the control module in accordance with the battery information. The control module is configured to receive the sensing signal from the sensing module and output a control signal in accordance with the battery information. The DC/DC converter has a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the common line. The DC/DC converter is operative to transfer energy between the first and second ports to feed and/or drain a battery connected to the common line when in use in accordance with the control signal. *See*, *e.g.*, paragraphs [0061]-[0065] of application publication US 2006/0193095.

Some embodiments of the present invention according to independent Claim 8 provide a battery management apparatus for managing a substring of cells (see, *e.g.*, substring 1240) in a string of cells (see, *e.g.*, Fig. 12, string 1230). The apparatus comprises a DC bus (see, *e.g.*, Fig. 12, DC/DC converter 1202) and a multiplexer/demultiplexer circuit (see, *e.g.*, Fig. 12, Mux/Demux 1201) operative to selectively couple nodes of the substring of cells to the DC bus. The apparatus also includes a DC/DC converter circuit (see, *e.g.*, Fig. 12, DC/DC converter 1202) having a first port (see, *e.g.*, Fig. 12, port 1209) configured to be coupled across a plurality of cells of the string and a second port (see, *e.g.*, Fig. 12, port 1211) coupled to the DC bus, the DC/DC converter operative to transfer energy between the first and second ports. The apparatus further includes a sensor circuit (see, *e.g.*, Fig. 12, sensing circuit 1203) coupled to the DC bus and a controller circuit (see, *e.g.*, Fig. 12, controller 1206) configured to connect to a communications bus and operatively associated with the multiplexer/demultiplexer circuit, the DC/DC converter and the sensor circuit. *See*, *e.g.*, paragraphs [0061]-[0065] of application publication US 2006/0193095.

In some embodiments of the present invention according to Claim 11, which depends from Claims 8 and 9, the apparatus further includes a ground bus, the

multiplexer/demultiplexer circuit (see, *e.g.*, Fig. 13, Mux/Demux 1310) is operative to selectively connect the nodes to the DC bus and the ground bus, and the second port (see, *e.g.*, Fig. 13, port 1312) of the DC/DC converter circuit (see, *e.g.*, Fig. 13, DC/DC converter 1310) is coupled to the DC bus and the ground bus. The DC/DC converter circuit further comprises a third port (see, *e.g.*, Fig. 13, port 1313) and is operative to transfer energy between the first and third ports, and at least one of the controller circuit (see, *e.g.*, Fig. 13, microcontroller 1315), the multiplexer/demultiplexer circuit and the sensor circuit (see, *e.g.*, Fig. 13, A/D of microcontroller 1315) are configured to be powered from the third port. *See*, *e.g.*, paragraphs [0066]-[0069] of application publication US 2006/0193095.

In some embodiments of the present invention according to Claim 12, which depends from Claim 11, the DC/DC converter circuit further comprises a fourth port (see, *e.g.*, Fig. 13, port 1314) configured to be coupled to a power supply bus (see, *e.g.*, Fig. 13, power bus 1250) associated with the communications bus (see, *e.g.*, Fig. 13, CAN communications bus 1220) and is operative to transfer energy between the fourth port and the third port to power to at least one of the controller circuit, the multiplexer/demultiplexer circuit and the sensor circuit. *See*, *e.g.*, paragraph [0069] of application publication US 2006/0193095.

In some embodiments of the present invention according to Claim 13, which depends from Claims 8 and 9, the controller circuit is operative to cause the multiplexer/demultiplexer circuit to couple the DC bus and the ground bus to respective selected first and second nodes of the substring of cells, to cause the sensor circuit to sense a voltage between the DC bus and the ground bus and to cause the DC/DC converter circuit to transfer energy between the selected first and second nodes and the plurality of cells of the strings responsive to the sensed voltage. *See*, *e.g.*, paragraphs [0066]-[0069] of application publication US 2006/0193095.

In some embodiments of the present invention according to Claim 15, which depends from Claims 8 and 9, the controller circuit is operative to cause the multiplexer/demultiplexer circuit to couple the DC bus and the ground bus to respective selected first and second nodes of the substring of cells, to cause the DC/DC converter circuit to transfer energy between the selected first and second nodes and the plurality of cells of the strings responsive to the sensed voltage, to cause the sensor circuit to sense a voltage between the DC bus and the ground bus and/or a current at the DC bus responsive to the transfer of energy. *See*, *e.g.*, paragraphs [0066]-[0069] of application publication US 2006/0193095.

Some embodiments of the present invention according to Claim 25 provide a plurality of battery management apparatus according to Claim 8, respective ones of which are connected to respective substrings of the string of serially-connected cells, wherein the controller circuits of the plurality of battery management apparatus are coupled to the same communications bus. *See, e.g.*, Figs. 1 and 2; paragraphs [0034], [0035] and [0061].

## Grounds of Rejection to be Reviewed on Appeal

1. Are Claims 1-5, 7-13, 15-22, 25 and 27 properly rejected under 35 U.S.C. §102(b) as being unpatentable over U.S. Patent No. 5,498,950 to Ouwerkerk (hereinafter "Ouwerkerk")? (Final Action, p. 2)

2. Are Claims 6, 23, 24 and 26 properly rejected under 35 U.S.C. §103 as unpatentable over Ouwerkerk in view of U.S. Patent No. 4,709,202 to Koenck (hereinafter "Koenck")? (Final Action, p. 4.)

## Argument

### I. Introduction

Claims 1-5, 7-13, 15-22, 25 and 27 stand rejected as allegedly anticipated. To anticipate a claim, the reference must teach every element of the claim. M.P.E.P. § 2131. "A claim is anticipated only if each and every element as set forth in the claim is found, either expressly or inherently described, in a single prior art reference." *Verdegaal Bros. v. Union Oil Co. of California*, 814 F.2d 628, 631, 2 USPQ2d 1051, 1053 (Fed. Cir. 1987). "The identical invention must be shown in as complete detail as is contained in the ... claim." *Richardson v. Suzuki Motor Co.*, 868 F.2d 1226, 1236, 9 USPQ2d 1913, 1920 (Fed. Cir. 1989).

Claims 6, 23, 24 and 26 stand rejected as allegedly obvious. To establish a *prima facie* case of obviousness under 35 U.S.C. § 103, the prior art reference or references, when combined, must teach or suggest all the recitations of the claims, and there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference

teachings. M.P.E.P. §2143. As stated in the "Examination Guidelines for Determining Obviousness Under 35 U.S.C. §103 in view of the Supreme Court Decision in *KSR International Co. v. Teleflex Inc.*" (M.P.E.P. §2141), a question regarding whether a claimed invention is obvious under 35 U.S.C. § 103 must include an analysis of the factors set forth in *Graham v. John Deere Co.* (383 U.S. 1, 148 USPQ 459 (1966)), which are described by the Supreme Court in the *KSR* decision to be 1) determining the scope and content of the prior art; 2) ascertaining the differences between the claimed invention and the prior art; and 3) resolving the level of ordinary skill in the pertinent art (hereinafter, the "*John Deere* factors"). The key to supporting any rejection under 35 U.S.C. 103 is the clear articulation of the reason(s) why the claimed invention would have been obvious. M.P.E.P. § 2143. A patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in the prior art. *KSR Int'l Co. v. Teleflex Inc.*, 550 U. S. 1, 15 (2007). A Court must ask whether the improvement is more than the predictable use of prior art elements according to their established functions. *Id.* at 13. When it is necessary for a Court to look at interrelated teachings of multiple patents, the Court must determine whether there was an apparent reason to combine the known elements in the fashion claimed by the patent at issue. *Id.* at 14.

## II. Claims 1-5, 7-13, 15-22, 25 and 27 are patentable

### A. Claims 1-5 and 7 are patentable

Independent Claims 1 and 3 stand rejected as allegedly anticipated by U.S. Patent No. 5,498,950 to Ouwerkerk ("Ouwerkerk"). Final Action, p. 2. Claim 1 recites:

> A battery management system for managing a string of cells including a sensing module; a DC/DC converter; a control module coupled to the sensing module and the DC/DC converter; and a common line coupled to both the sensing module and the DC/DC converter and adapted for connection to a battery when in use, wherein the sensing module is configured to receive battery information from the common line and output a sensing signal to the control module in accordance with the battery information, wherein the control module is configured to receive the sensing signal from the sensing module and output a control signal in accordance with the battery information, and wherein the DC/DC converter has a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the common line, the DC/DC converter operative to transfer energy between the first and second ports to feed and/or drain a battery connected to the common line when in use in accordance with the control signal.

Appellants' Amendment filed March 26, 2008 explained why Ouwerkerk fails to teach or suggest several of the recitations of independent Claim 1.

In particular, the Final Action alleges that the "independent controller" described at col. 3, line 24 of Ouwerkerk corresponds to the recited DC/DC converter. Final Action, p. 2. Ouwerkerk indicates that the controller couples the battery pack 13 to the power source 30, but is silent at to what this independent controller is and does not imply that it is a DC/DC converter. Indeed, as Ouwerkerk pertains to electric vehicles, this independent controller could be, for example, a circuit for charging the battery pack from an AC mains power source, *e.g.*, the independent controller could be an AC/DC converter that transforms the AC power from the power source to the required DC voltage to charge the battery.

Even if the independent controller shown in Ouwerkerk were a DC/DC converter (which Appellants deny), there is no teaching or suggestion that the independent controller is configured as recited in Claim 1. As described in Ouwerkerk, it appears that the independent controller is merely an interface between the battery pack and its associated power source.

Ouwerkerk also fails to disclose or suggest that the "independent controller" is coupled to a common line to which a sensing module is also connected. Again, as described in Ouwerkerk, it appears that the independent controller is merely an interface between the battery pack 13 and its associated power source 30.

Furthermore, the independent controller described in Ouwerkerk does not appear to have "a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the common line" and does not appear to be "operative to transfer energy between the first and second ports to feed and/or drain a battery connected to the common line when in use in accordance with the control signal." In fact, as described in Ouwerkerk, the independent controller merely couples the power source to the battery pack and does not appear to utilize any control signals from either of the sensing modules 22, 25.

In response to these arguments, the "Response to Arguments" section of the Final Action states that "Ouwerkerk's disclosed independent control (col. 3, line 24) is electrically coupled to the control module (Fig. 2, 14) and a common line." Final Action, p. 6. Respectfully, there is no basis for this assertion. Ouwerkerk merely states that "the power source 30 may be coupled through an independent controller (not shown) to the battery pack." Ouwerkerk, column 3, lines 22-24. There is no description of the controller 14 shown

in Fig. 2 as being coupled to the "independent controller" described at column 3, line 24, which is a description of Fig. 1 of Ouwerkerk.

Moreover, there is no description in Ouwerkerk that the "independent controller" described at column 3, line 24 is coupled to a common line as recited in Claim 1. The Final Action asserts that sensors 19 correspond to the recited sensing modules of Claim 1. Final Action, p. 2. If this were the case, however, Ouwerkerk does not disclose or suggest "a common line" that is coupled to both the sensors 19 and the "independent controller" (the alleged "DC/DC converter.")

The Final Action further argues:

> . . . the recitation of 'operative to transfer energy between the first and second powers to feed and/or drain a battery connected to the common line when in use in accordance with the control signal and operative to selectively couple nodes of the substring of cells to the DC bus' is only a statement of inherent properties of the 'decoder and driver circuit.' The structure recited in "Ouwerkerk" is substantially identical to that of the claims, claimed properties or functions are presumed to be inherent. Or where the claimed and prior art products are identical or substantially identical in structure or composition, or are produced by identical or substantially identical processes, a prima facie case of either anticipation or obviousness has been established.

Respectfully, this reasoning relies on a flawed premise. In particular, the Final Action fails to show that the structures shown in Ouwerkerk are "identical or substantially identical" to the structure recited in Claim 1, as Appellants have shown that the structure shown in Ouwerkerk lacks several of the features recited in Claim 1. Therefore, the Final Action's reasoning regarding the functional recitations of Claim 1 is erroneous, *i.e.*, these functions are not inherent in the structures described in Ouwerkerk.

Thus, Ouwerkerk fails to disclose or suggest the recitations of independent Claim 1 and, for at least these reasons, Appellants submit that Claim 1 is patentable. For at least similar reasons, Ouwerkerk also fails to disclose or suggest the recitations of independent Claim 3. Accordingly, Appellants submit that the rejections of independent Claims 1 and 3 are erroneous and should be withdrawn. Appellants further submit that dependent Claims 2-5 and 7 are patentable at least by virtue of the patentability of independent Claim 1 from which they depend and that, therefore, the rejections of the these claims are erroneous and should be reversed.

**B. Claims 8-13, 15-22, 25 and 27 are patentable**

Independent Claim 8 also stands rejected as allegedly anticipated by Ouwerkerk. Final Action, p. 2. Independent Claim 8 recites:

> A battery management apparatus for managing a substring of cells in a string of cells, the apparatus comprising:
> a DC bus;
> a multiplexer/demultiplexer circuit operative to selectively couple nodes of the substring of cells to the DC bus;
> a DC/DC converter circuit having a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the DC bus, the DC/DC converter operative to transfer energy between the first and second ports;
> a sensor circuit coupled to the DC bus; and
> a controller circuit configured to connect to a communications bus and operatively associated with the multiplexer/demultiplexer circuit, the DC/DC converter and the sensor circuit.

The Final Action asserts that the charging lines 31 of Fig. 2 of Ouwerkerk correspond to the "DC bus" recited in Claim 8, and that the decoder and driver circuit 18 shown in Fig. 2 of Ouwerkerk correspond to the "multiplexer/demultiplexer circuit" recited in Claim 8. Final Action, p. 2. However, Appellants note there is no teaching or suggestion in Ouwerkerk that the decoder and driver circuit 18 is "operative to selectively couple nodes of the substring of cells to the DC bus." Rather, the decoder and driver circuit 18 operates a set of switches 21 to connect nodes of the battery pack 13 to an isolated current source 24, which is described as "typically a low current source, such as may be provided by a 0.5 amp current source, for example." Ouwerkerk, column 4, lines 9-11. The decoder and driver circuit 18 does not selectively couple any of the individual battery nodes to the charging lines 31, as the charging lines 31 are fixedly connected to the end terminals of the battery pack 13.

For reasons along the lines discussed above with reference to independent Claims 1 and 3, Ouwerkerk also fails to disclose or suggest "a DC/DC converter circuit having a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the DC bus, the DC/DC converter operative to transfer energy between the first and second ports" as recited in Claim 8. In particular, as discussed above, Ouwerkerk does not teach a DC/DC converter at all, much less one with ports connected in the manner recited in independent Claim 8.

Ouwerkerk also fails to disclose or suggest "a controller circuit configured to connect to a communications bus and operatively associated with the multiplexer/demultiplexer

circuit, the DC/DC converter and the sensor circuit." The Final Action asserts that the DC/DC converter is the "independent controller" coupling the power source to the battery pack. Final Action, p. 2. However, Ouwerkerk contains no teaching or suggestion that the independent controller is operatively associated with the controller 14. Indeed, it appears that the purpose of the independent controller is merely to provide a coupling arrangement between the power source 30 and the battery pack 13, and this part of the system is not controlled in any way by the charge controller 14, *i.e.*, the "independent controller" is ***independent***. Instead, it appears that the charge controller 14 is used to modify the charge within each battery cell by selectively charging the individual battery cells using the isolated current source 24. *See, e.g.*, Ouwerkerk, column 5, lines 51-59.

Accordingly, Appellants submit that Ouwerkerk fails to disclose or suggest several of the recitations of independent Claim 8. For at least these reasons, Appellants submit that independent Claim 8 is patentable and the rejection thereof should be reversed. Appellants further submit that dependent Claims 7-13, 15-22, 25 and 27 are patentable at least by virtue of the patentability of independent Claim 8 from which they depend and that, therefore, the rejections of these claims should be reversed.

**C. Dependent Claim 11 is separately patentable**

Claim 11, which stands rejected as allegedly anticipated by Ouwerkerk (Final Action, p. 2), recites "wherein the DC/DC converter circuit further comprises a third port and is operative to transfer energy between the first and third ports, and wherein at least one of the controller circuit, the multiplexer/demultiplexer circuit and the sensor circuit are configured to be powered from the third port." The Final Action fails to provide any indication as to where Ouwerkerk teaches or suggests such recitations, and Appellants submit that Ouwerkerk is devoid of such teachings. For at least these reasons, Appellants submit that Claim 11 is separately patentable.

**D. Dependent Claim 12 is separately patentable**

Claim 12, which also stands rejected as allegedly anticipated by Ouwerkerk (Final Action, p. 2) recites "wherein the DC/DC converter circuit further comprises a fourth port configured to be coupled to a power supply bus associated with the communications bus and

is operative to transfer energy between the fourth port and the third port to power to at least one of the controller circuit, the multiplexer/demultiplexer circuit and the sensor circuit." As with Claim 11, the Final Action fails to provide any indication as to where Ouwerkerk teaches or suggests such recitations, and Appellants submit that Ouwerkerk is devoid of such teachings. For at least these reasons, Appellants submit that Claim 12 is separately patentable.

**E. Dependent Claims 13 and 15 are separately patentable**

Claim 13, which also stands rejected as allegedly anticipated by Ouwerkerk (Final Action, pp. 2 and 3), recites "wherein the controller circuit is operative to cause the multiplexer/demultiplexer circuit to couple the DC bus and the ground bus to respective selected first and second nodes of the substring of cells, to cause the sensor circuit to sense a voltage between the DC bus and the ground bus and to cause the DC/DC converter circuit to transfer energy between the selected first and second nodes and the plurality of cells of the strings responsive to the sensed voltage." The Final Action asserts "Ouwekerk (sic) discloses when the battery voltage sensing circuit (22) senses the voltage (which also meets applicant's determine a status) of the each of the plurality of batteries and if a certain voltage is detected an order to charge the battery to a proper voltage is activated (col. 4, lines 33-37). Final Action, p. 3.

This argument does not support a conclusion that Ouwerkerk teaches the recitations of Claim 13. Appellants do not dispute that Ouwerkerk related to charging selected batteries, but Ouwerkerk describes selectively transferring energy to nodes of a battery pack 13 using ***an isolated current source 24***, not transferring energy among cells, *i.e.*, ***between the selected first and second nodes and the plurality of cells of the strings***, as recited in Claim 13. Accordingly, Ouwerkerk does not disclose or suggest the recitations of Claim 13 and, for at least these reasons, Appellants submit that Claim 13 is separately patentable. At least similar reasons support the separate patentability of Claim 15.

**F. Dependent Claim 25 is separately patentable**

Claim 25, which stands rejected as allegedly anticipated by Ouwerkerk (Final Action, p. 2), recites "[a] plurality of battery management apparatus according to Claim 8, respective ones of which are connected to respective substrings of the string of serially-connected cells,

wherein the controller circuits of the plurality of battery management apparatus are coupled to the same communications bus." The Final Action provides no indication as to where Ouwerkerk teaches or suggests such recitations, and Appellants submit that Ouwerkerk is devoid of such teachings. For at least these reasons, Appellants submit that Claim 25 is separately patentable.

## III. Dependent Claims 6, 23, 24 and 26 are patentable

Appellants submit that dependent Claims 6, 23, 24 and 26 are patentable at least by virtue of the patentability of the respective ones of independent Claims 3 and 8 from which they depend. Accordingly, the rejections of these claims should be reversed.

## IV. Conclusion

In light of the above discussion, Appellants submit that the pending claims are directed to patentable subject matter and, therefore, request reversal of the rejections of those claims and passing of the application to issue.

It is not believed that an extension of time and/or additional fee(s) are required, beyond those that may otherwise be provided for in documents accompanying this paper. In the event, however, that an extension of time is necessary to allow consideration of this paper, such an extension is hereby petitioned for under 37 C.F.R. §1.136(a). Any additional fees believed to be due in connection with this paper may be charged to Deposit Account No. 50-0220.

Respectfully submitted,

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**CERTIFICATION OF TRANSMISSION**

I hereby certify that this correspondence is being transmitted via the Office electronic filing system in accordance with § 1.6(a)(4) to the U.S. Patent and Trademark Office on December 1, 2008.

Audra Wooten

**APPENDIX A**
Pending Claims
USSN 10/528,897
Filed: September 24, 2003

1. (Previously Presented) A battery management system for managing a string of cells including a sensing module; a DC/DC converter; a control module coupled to the sensing module and the DC/DC converter; and a common line coupled to both the sensing module and the DC/DC converter and adapted for connection to a battery when in use, wherein the sensing module is configured to receive battery information from the common line and output a sensing signal to the control module in accordance with the battery information, wherein the control module is configured to receive the sensing signal from the sensing module and output a control signal in accordance with the battery information, and wherein the DC/DC converter has a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the common line, the DC/DC converter operative to transfer energy between the first and second ports to feed and/or drain a battery connected to the common line when in use in accordance with the control signal.

2. (Previously Presented) A system according to claim 1 including a multiplexer for selectively connecting a plurality of batteries to the common line.

3. (Currently Amended) A battery management system for managing a string of cells including a sensing module; a DC/DC converter; and a control module coupled to the sensing module and the DC/DC converter; wherein the sensing module is configured to receive battery information <u>from a common line</u> and output a sensing signal to the control module in accordance with the battery information, wherein the control module is configured to receive the sensing signal from the sensing module and output a control signal in accordance with the battery information, wherein the DC/DC converter has a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the common line, the DC/DC converter operative to transfer energy between the first and second ports to feed and/or drain a battery connected to the DC/DC converter when in use in accordance with the control signal in order to perform equalisation of [[a]] <u>the</u> string of serially connected batteries, and wherein the control module is configured to perform one or more additional battery monitoring or management tasks.

4. (Original) A system according to claim 3 wherein the one or more additional battery monitoring or management tasks include impedance testing.

5. (Previously Presented) A system according to claim 3 wherein the one or more additional battery monitoring or management tasks include capacity testing.

6. (Previously Presented) A system according to claim 1 wherein the sensing module, DC/DC converter and control modules are enclosed in a battery compartment.

7. (Previously Presented) A system according to claim 1 including a multiplexer for selectively connecting a plurality of batteries to the sensing module and/or the DC/DC module.

8. (Original) A battery management apparatus for managing a substring of cells in a string of cells, the apparatus comprising:

a DC bus;

a multiplexer/demultiplexer circuit operative to selectively couple nodes of the substring of cells to the DC bus;

a DC/DC converter circuit having a first port configured to be coupled across a plurality of cells of the string and a second port coupled to the DC bus, the DC/DC converter operative to transfer energy between the first and second ports;

a sensor circuit coupled to the DC bus; and

a controller circuit configured to connect to a communications bus and operatively associated with the multiplexer/demultiplexer circuit, the DC/DC converter and the sensor circuit.

9. (Original) An apparatus according to Claim 8, further comprising a ground bus, wherein the multiplexer/demultiplexer circuit is operative to selectively connect the nodes to the DC bus and the ground bus, and wherein the second port of the DC/DC converter circuit is coupled to the DC bus and the ground bus.

10. (Original) An apparatus according to Claim 9, wherein the first and second ports of the DC/DC converter circuit are isolated from one another.

11. (Original) An apparatus according to Claim 9, wherein the DC/DC converter circuit further comprises a third port and is operative to transfer energy between the first and third ports, and wherein at least one of the controller circuit, the multiplexer/demultiplexer circuit and the sensor circuit are configured to be powered from the third port.

12. (Original) An apparatus according to Claim 11, wherein the DC/DC converter circuit further comprises a fourth port configured to be coupled to a power supply bus associated with the communications bus and is operative to transfer energy between the fourth port and the third port to power to at least one of the controller circuit, the multiplexer/demultiplexer circuit and the sensor circuit.

13. (Original) An apparatus according to Claim 9, wherein the controller circuit is operative to cause the multiplexer/demultiplexer circuit to couple the DC bus and the ground bus to respective selected first and second nodes of the substring of cells, to cause the sensor circuit to sense a voltage between the DC bus and the ground bus and to cause the DC/DC converter circuit to transfer energy between the selected first and second nodes and the plurality of cells of the strings responsive to the sensed voltage.

14. (Original) An apparatus according to Claim 9, wherein the controller circuit is operative to adjust the cells of the string by causing the multiplexer/demultiplexer circuit and the DC/DC converter circuit to transfer energy between at least one cell of the substring and the plurality of cells.

15. (Original) An apparatus according to Claim 9, wherein the controller circuit is operative to cause the multiplexer/demultiplexer circuit to couple the DC bus and the ground bus to respective selected first and second nodes of the substring of cells, to cause the DC/DC converter circuit to transfer energy between the selected first and second nodes and the plurality of cells of the strings responsive to the sensed voltage, to cause the sensor circuit to sense a voltage between the DC bus and the ground bus and/or a current at the DC bus responsive to the transfer of energy.

16. (Original) An apparatus according to Claim 15, wherein the controller circuit is further operative to determine a status of at least one cell of the substring responsive to the sensed voltage and/or current.

17. (Original) An apparatus according to Claim 15, wherein the controller circuit is operative to transmit battery information over the communications bus responsive to the sensed voltage.

18. (Original) An apparatus according to Claim 9, wherein the controller circuit is operative to cause the multiplexer/demultiplexer circuit and the DC/DC converter circuit to load at least one cell of the substring while causing the sensor circuit to generate test data for the loaded at least one cell.

19. (Original) An apparatus according to Claim 18, wherein controller circuit is further operative to process the generated test data to determine a status of the at least one cell.

20. (Original) An apparatus according to Claim 19, wherein the controller circuit is operative to generate at least one of an estimate of capacity and an estimate of reserve life from the generated test data.

21. (Original) An apparatus according to Claim 20, wherein the controller circuit is operative to transmit the at least one of an estimate of capacity and an estimate of reserve life over the communications bus.

22. (Original) An apparatus according to Claim 18, wherein the controller circuit is further operative to transmit cell information on the communications bus responsive to the generated test data.

23. (Original) An apparatus according to Claim 8, wherein the sensor circuit comprises an analog to digital (A/D) converter circuit operative to generate a digital value representative of a voltage at the DC bus and wherein the controller circuit is operative to receive the digital value.

24. (Original) An apparatus according to Claim 8:

wherein the sensor circuit comprises:

a current sensor operative to generate a voltage responsive to a current in the DC bus; and

an A/D converter circuit coupled to the current sensor and operative to generate a digital value representative of the voltage generated by the current sensor; and

wherein the controller circuit is operative to receive the digital value.

25. (Original) A plurality of battery management apparatus according to Claim 8, respective ones of which are connected to respective substrings of the string of serially-connected cells, wherein the controller circuits of the plurality of battery management apparatus are coupled to the same communications bus.

26. (Previously Presented) A system according to claim 3 wherein the sensing module, DC/DC converter and control modules are enclosed in a battery compartment.

27. (Previously Presented) A system according to claim 3 including a multiplexer for selectively connecting a plurality of batteries to the sensing module and/or the DC/DC converter.

## APPENDIX B – EVIDENCE APPENDIX

**(NONE)**

## APPENDIX C – RELATED PROCEEDINGS

**(NONE)**